Replaced by 16JA-250 1/29/69

Hermetic Absorption Liquid Chillers

MACHINE OPERATION

MACHINE START-STOP SYSTEMS

General - The exact start-stop system for a given machine is established by the customer. Systems can vary from one installation to another. These systems and procedures are meant for general guidelines only.

The three most common types of systems are given below. Review these systems and decide which applies to your machine. Then follow the start-stop procedure given.

NOTE: If machine has been shut down for more than 2 days, follow procedures under Start-Up After Limited Shutdown or Start-Up After Extended Shutdown. In all cases below, when machine starts, the white run light will energize. When the machine stops, the light will go out after automatic dilution.

Automatic Start-Stop System - Starting and stopping with this system is accomplished by an automatic controller such as a thermostat or time clock, etc. Also, an AUTO-MANUAL switch is provided so the machine can be started by pressing machine START button with switch in MANUAL position. All auxiliary equipment is tied in with the machine control circuit and will start when the machine starts. If automatic time delay relays are provided, the machine will start after a preselected time interval.

The operating engineer must make periodic checks to ensure that the machine with auxiliary equipment is operating satisfactorily.

PROCEDURES

1. Place AUTO-MANUAL switch in the AUTO position for the machine to start or stop automatically. The automatic controller determines when the machine starts or stops.
2. To start fully automatic machines after limited or extended shutdown place the AUTO-MANUAL switch in MANUAL and press the START button. Then follow start-up procedures for limited or extended shutdown. Only after manual start has been completed should the AUTO-MANUAL switch be placed in AUTO.

   NOTE: When the machine shuts down either automatically or manually, the refrigerant and solution pumps will continue to run until automatic dilution is completed.

Semiautomatic Start-Stop System - All auxiliary equipment used with this system is tied directly to the control circuit. It is necessary for the operating engineer to press the START button to start the condensing water pump, chilled water pump, machine pumps, and cooling tower fan (if used).

PROCEDURES

1. Press STOP button to stop machine. Press START button to start machine.

   NOTE: On shutdown the machine pumps will continue to run until automatic dilution is completed.

Semiautomatic Start-Stop System with Manual Auxiliaries - All auxiliaries must be started manually.

PROCEDURES

1. Start chilled water pump.
2. Start condensing water pump.
3. Start cooling tower fan (if used). (This depends on outside temperature.)
4. Press START button to start machine.
5. To stop machine, press STOP button. Then stop the following:
   a. Cooling tower fan (if used).
   b. Condenser water pump.
   c. Chilled water pump.

   NOTE: The refrigerant and solution pumps will continue to run until automatic dilution is completed.

MACHINE START-UP PROCEDURES

General - Procedures for start-up differ depending on how long the machine has been shut down. There are two start-up procedures: Start-up after limited shutdown (3 days to 3 weeks), and start-up after extended shutdown (over 3 weeks).

Start-Up After Limited Shutdown

PROCEDURES

1. Start the machine as outlined for your system under Machine Start-Stop Systems.
2. Check the leaving chilled water temperature. If temperature drops to design, then steps 3 and 4 are not necessary. If the temperature does not drop to design, noncondensables are probably present in the machine. Proceed with steps 3 and 4.
3. Determine the amount of noncondensables by taking an absorber loss reading (the temperature difference between the refrigerant and solution vapor). To determine absorber loss, refer to Carrier Standard Service Techniques, publication SM-16. A machine with absorber loss of less than 6 F can normally be started without the machine solution becoming solidified. If absorber loss is greater than 6 F, auxiliary evacuation is recommended. A machine fully evacuated will normally have an absorber loss of 2 F or less. Instructions for auxiliary evacuation are in Carrier Standard Service Techniques, publication SM-16.

To prevent solidification while purging:

a. Place reclaim switch to MANUAL.

b. Throttle back steam control valve.

(1) Electronic Control - Turn the control point adjustor up approximately ten degrees (ten divisions).

(2) Pneumatic Control - Turn the chilled water thermostat set point up ten degrees.

4. Evaluate machine tightness with a noncondensable accumulation rate check. Refer to Carrier Standard Service Techniques, publication SM-16.

Start-Up After Extended Shutdown - This procedure is critical since accumulated noncondensables may allow the machine solution to solidify if the following precautions are not taken.

PROCEDURES

1. Start the machine as outlined for your system under Machine Start-Up Procedures. Make sure steam valve is closed. If absorber solution level is high (above 9 in.) and refrigerant pump is noisy, open steam valve until absorber level indicator shows approximately 9 in. of solution, then close steam valve. Place refrigerant pump switch in ON position.
2. Determine absorber loss by following procedures outlined in Carrier Standard Service Techniques, publication SM-16.
   a. If absorber loss is less than 6 F, open steam valve and allow machine to go into automatic operation.
   b. If absorber loss is 6 F or greater, auxiliary evacuation is required. Use instructions for auxiliary evacuation provided in Carrier Standard Service Techniques, publication SM-16.
3. Continue auxiliary evacuation until absorber loss is less than 6 F. Place machine in automatic operation.
4. After auxiliary evacuation, evaluate machine tightness with a noncondensable accumulation rate check.

WINTER CONDITIONS

General - At the end of each cooling season when the machine is no longer required use one of the following winter shutdown procedures. The choice depends on whether the machine ambient temperature will be kept above or below freezing.

Shutdown Procedures

BELOW FREEZING

1. Stop machine and wait until automatic dilution completes and machine pumps stop.
2. Set dilution thermostat to its lowest possible setting.
3. Connect a hose between solution and refrigerant pump service valves. Open both valves.
4. Switch refrigerant pump ON-OFF switch to OFF and solution pump switch to ON.
5. Press START button and allow solution pump to run for approximately 5 minutes.

   NOTE: This procedure contaminates the refrigerant with lithium bromide solution lowering the refrigerant freezing point.
6. Press STOP button and reset dilution thermostat to 140 F (refer to Checking Dilution Thermostat under Maintenance).
7. Drain water from all chilled water, condensing, steam and condensate circuits. Flush all circuits with ethylene glycol.

ABOVE FREEZING

1. Press STOP button.
2. Allow machine to go thru automatic dilution. When dilution has completed, machine may be left in this condition until spring start-up.

Start-Up Procedures

BELOW FREEZING

1. Refill all water circuits that were drained at shutdown.
2. Follow Start-Up After Extended Shutdown procedures.
3. Reclaim lithium bromide from refrigerant circuit. Follow Reclaim Solution procedures given under Maintenance.
4. Restart machine.

ABOVE FREEZING

1. If machine vacuum was broken for maintenance work, etc., follow auxiliary evacuation procedures outlined in Carrier Standard Service Techniques, publication SM-16. Then follow Start-Up After Extended Shutdown procedures.
2. If machine vacuum was not broken, follow Start-Up After Extended Shutdown procedures.

PURGE OPERATION

General - The 16JA purge unit automatically performs the following functions:

1. Removes noncondensables from the machine.
2. Accumulates these noncondensables in the purge storage chamber where they will not affect the machine performance.
3. Provides an indication of the degree of air leakage into the machine.

The 16JA purge unit cannot be used as an auxiliary evacuation device to evacuate the machine.

When the purge exhaust light (red) is energized during machine operation, it indicates that the purge must be manually exhausted. For instructions refer to the instruction sticker located on the separation chamber (Fig. 1) or use the following procedure.

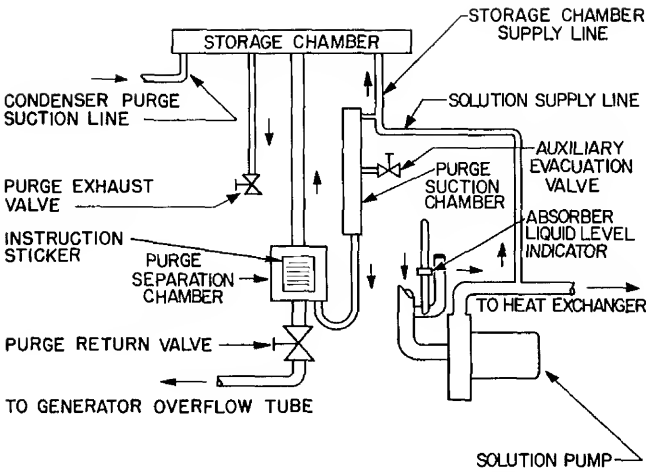

Fig. 1 - Purge Exhaust System

Manual Exhaust Procedures

1. Close purge return valve.
2. Wait 10 minutes for storage chamber to pressurize.
3. Slowly open purge exhaust valve. If level in container drops, shut valve and wait 2 minutes. Reopen valve. If bubbles appear, keep valve open until bubbles stop and level in container rises, then close valve.
4. Collect lithium bromide solution to recharge into machine. Recharging procedures are given in Carrier Standard Service Techniques, publication SM-16.

SOLUTION DESOLIDIFICATION

General - Should solidification occur, it will occur usually in the shell side of the heat exchanger, preventing the strong solution in the generator from returning to the absorber thru the strong solution line. However, the strong solution will be returned to the absorber thru the generator overflow tube (Fig. 6) thereby desolidifying automatically.

If during a shutdown period solidification has occurred to the extent that the solution pump will not rotate and the motor overloads trip out, desolidify by using the following procedure.

PROCEDURE

1. Heat the pump casing and adjacent lines with steam until the pump will rotate. Be careful not to allow steam and condensate to enter the pump motor and controls.

   WARNING: Special precautions must be taken with hermetic pumps. The pump casing may be warmed with steam, but, under no circumstances should the motor be heated directly. If a heating torch is used, under no circumstances should heat be applied directly to any flange connection as the very high temperature will deteriorate the gasket material used.

2. Confirm pump rotation. Rotation of the hermetic pump cannot be viewed directly. Install a compound pressure gage on the solution pump service valve. With correct pump rotation, the gage will indicate a positive reading above atmospheric pressure. If the pump is solidified, the gage will indicate atmospheric pressure. If the casing is partially desolidified and the pump will not turn, the pressure gage will indicate a deep vacuum. Continue to heat the casing until the pump is desolidified. Desolidification of the heat exchanger will take place automatically once the pump starts functioning.
3. Refer to Troubleshooting Guide for possible causes of solidification and their correction.

MAINTENANCE

INTRODUCTION

General - The following are routine steps necessary for normal preventive maintenance on 16JA Hermetic Absorption Liquid Chillers.

To ensure the continued satisfactory performance of the machine, these schedules must be closely adhered to.

We recommend the suggested steps be performed as often as indicated, and that an accurate log be kept to aid in diagnosing any troubles.

Certain components and operations should be checked on an individual basis as needed.

EACH MONTH

Reclaim Solution - During normal operation it is possible that some lithium bromide might carry over into the refrigerant circuit.

To determine if contamination exists, remove a refrigerant sample from the machine using refrigerant and solution sampling procedures outlined in Carrier Standard Service Techniques, publication SM-16. Measure the specific gravity of the sample. If the value exceeds 1.02, the solution must be reclaimed.

RECLAIM PROCEDURE FOR CONTINUOUS OPERATION

1. Place reclaim valve switch in MANUAL position. Wait for approximately 15 minutes. This causes refrigerant to flow into the solution circuit where the lithium bromide solution is reclaimed.
2. Place reclaim switch in AUTO position, deenergizing the refrigerant solenoid valve, thus stopping refrigerant flow.

RECLAIM PROCEDURE FOR FREQUENT SHUTDOWN - When the machine is shut down, the reclaim valve will automatically reclaim the lithium bromide salt solution.

NOTE: If the reclaim solenoid valve does not energize during the reclaim procedure (audible click, and typical rattling noise of refrigerant passing thru the valve) contact your nearest Carrier representative for assistance.

Check Machine Tightness - The most important maintenance item on the absorption machine is maintaining vacuum tightness within acceptable limits. Check machine tightness by determining the noncondensable accumulation rate. Use procedures given in Carrier Standard Service Techniques, publication SM-16.

EVERY 2 MONTHS

Check Dilution Thermostat - The dilution thermostat should be open when the strong solution drops to 140 F. If temperature cutout point is not 140 F, insert screwdriver in slot on face of thermostat (located on strong solution line) and turn adjustment dial until cutout occurs at 140 F.

Check Low-Temperature Cutout - Remove low-temperature cutout sensing element from separable well in the evaporator shell. Place it in an ice bath. Low-temperature cutout should trip at 5 F below design leaving chilled water temperature or a minimum of 36 F. The actual cutout point is the dial setting less 3 F differential. When the control trips, the machine will shut down immediately without going thru a dilution cycle.

NOTE: The chilled water pump will continue to run if hooked up in the standard wiring arrangement.

EVERY 6 MONTHS

Check Evaporator Water Charge - Check the evaporator water charge to determine if the reclaim valve has energized. If valve has energized then either tube leakage or excess refrigerant is indicated.

Reclaim should start at full load (corresponds to approximately 62 percent lithium bromide in absorber for standard nominal conditions). Check as follows:

1. Operate machine at full load with design entering condensing water and design leaving chilled water.
2. Remove a sample of evaporator water from refrigerant pump service valve and check the specific gravity. If specific gravity is below 1.02 proceed with step 3. If specific gravity is above 1.02 reclaim solution (see instructions for Reclaim Solution, page 3) until specific gravity is below this point, then proceed with step 3.
3. Evaluate absorber loss. Should be 2 F or less. If more, purge air from machine.
4. Check reclaim line by feel. Listen for refrigerant flow (audible). If reclaim line is already cold, with audible refrigerant flow, remove refrigerant until reclaim valve closes (audible click) and refrigerant flow ceases.

If machine is operating under light load, it will be necessary to concentrate the absorber weak solution to 62 percent. To do this, raise entering condenser water temperature. Turn down control point adjuster below design leaving chilled water temperature setting. Repeat steps 1 thru 4.

Continual removal of water indicates leakage in one of the tube bundles. Leak test by using procedures outlined in Carrier Standard Service Techniques, publication SM-16.

Check Capacity Control Valve - Check to see if leaving chilled water is being maintained at design temperature. If not, adjust the electronic or pneumatic control.

TO ADJUST ELECTRONIC CONTROL

1. Move control point adjuster clockwise to increase temperature, or counterclockwise to decrease temperature. If this fails to bring leaving chilled water within design temperature, perform step 2.
2. Replace vacuum tubes in control motor. Make sure that new tubes are installed in correct plugs. If this fails to bring leaving chilled water within design temperature, proceed with step 3.
3. Clean relay contacts with stiff paper. If this fails to correct problem, contact Carrier immediately.

TO ADJUST PNEUMATIC CONTROL

1. Reset control point setting to design.
2. If above fails to correct problem, contact Carrier immediately.

Check Cooling Tower Bypass Control - If control is not maintaining design entering condensing water temperature, recalibrate the control thermostat. For information, contact the valve (or control) manufacturer.

EVERY YEAR

Check for Absorber and Condenser Scale - Check absorber and condenser tubes to see if cleaning is required. Soft scale may be removed with tube cleaning brushes. When hard scale has formed, it may be necessary to chemically clean the tubes. If a scale problem occurs, contact a water treatment representative. Annual tube cleaning may not be required if adequate water treatment is maintained.

Recharge Lithium Bromide - Recharge lithium bromide when the purge exhaust bottle becomes filled.

PROCEDURES

1. Open the exhaust valve and allow solution to be forced back into the purge.
2. Close the exhaust valve when the level nears the end of the tube. Do not allow air to be drawn into the tube.

EVERY 2 YEARS

Replace Service Valve Diaphragms - Requirement to replace valve diaphragms is determined by valve usage or number of machine operating hours. Less frequent usage of valves and lower number of machine operating hours results in longer life span for valve diaphragms. With minimum usage the requirement to replace diaphragms might be 3 years. With maximum usage they will need to be replaced in approximately 2 years.

PROCEDURES

1. Remove all solution and refrigerant from the machine.
2. Break vacuum with nitrogen unless performed previously. Refer to Carrier Standard Service Techniques, publication SM-16.
3. Remove solution and refrigerant from machine unless performed previously.

   NOTE: Store solution in clean containers for recharging.

4. Remove old valve diaphragms.
5. Install new valve diaphragms. Torque bolts to 3 ft lb.
6. Leak test all affected joints to make sure that all valves are leak tight.
7. Replace solution and refrigerant in machine.

   NOTE: The same quantity of solution and refrigerant removed from the machine must be charged back into the machine.

8. Re-evacuate the machine after service work is completed. See auxiliary evacuation procedures in Carrier Standard Service Techniques, publication SM-16.

EVERY 5 YEARS

Inspect Hermetic Pumps - Pumps used on Carrier Absorption Machines are hermetic and do not require seals. Pump motors are cooled by the fluid being pumped and are thermally protected with high-temperature cutouts (Klixons).

Inspect hermetic pumps and motors every 5 years or 20,000 hours, whichever comes first.

DISASSEMBLY PROCEDURES - Refer to Fig. 2 and Fig. 3.

1. Disconnect motor power leads at junction box on stator. Mark leads for ease in reassembly.
2. Remove bolts (item 1) holding motor adapter flange (item 2) to pump casing (item 3).

   NOTE: Use blocking to support weight of motor stator when removing bolts.

3. Pull stator and adapter flange straight back from pump casing. If paint has frozen flange to casing, gently pry between adapter flange and pump discharge pipe (item 4) until paint seal is broken.
4. Remove and discard gasket (item 5).
5. Remove impeller (item 6) by straightening locking tabs on impeller lock washer (item 7). Prevent impeller from rotating while removing locking bolt (item 8). Remove impeller key in the shaft.
6. Remove bearing and wearing ring housing:
   a. F-8 Frame Pumps (Fig. 2) - Unbolt cap screws (item 9). Remove bearing and wearing ring housing (item 10).

      CAUTION: Do not allow bearing to fall out of housing onto floor. Also be careful not to lose retaining clip (item 18) and spring (item 19).

   b. F-66 Frame Pumps (Fig. 3) - Remove stud nuts (item 9). Use jacking screws to loosen bearing and wearing ring housing (item 10). Insert jacking screws in tapped holes provided in wearing ring housing.
7. Slide out rotor (item 11) carefully, so as not to damage the stator can (item 12), rotor can (item 13), or motor end bearing (item 14).
8. Remove motor end bearing, retaining clip (item 15) and spring (item 16). Remove spring bearing plate (item 17) used on Frame F-8 only.

INSPECTION PROCEDURES

1. Check for bearing wear by measuring depth from large end to start of cone (Fig. 4). If wear exceeds 3/16 in., replace the bearing. Use standard parts lists for ordering new bearing.

   Instructions for bearing replacement are furnished with new bearing.

2. Check recirculation passages (item 20). Clean as required.
3. Check impeller stator can, rotor can and wearing rings for wear. Clean or replace if necessary.

   NOTE: If wearing rings require replacement, break the old ring with a chisel. These rings were staked in place. Do not restake new wearing ring.

4. Check spring loaded bearings for free movement within the bearing housing.

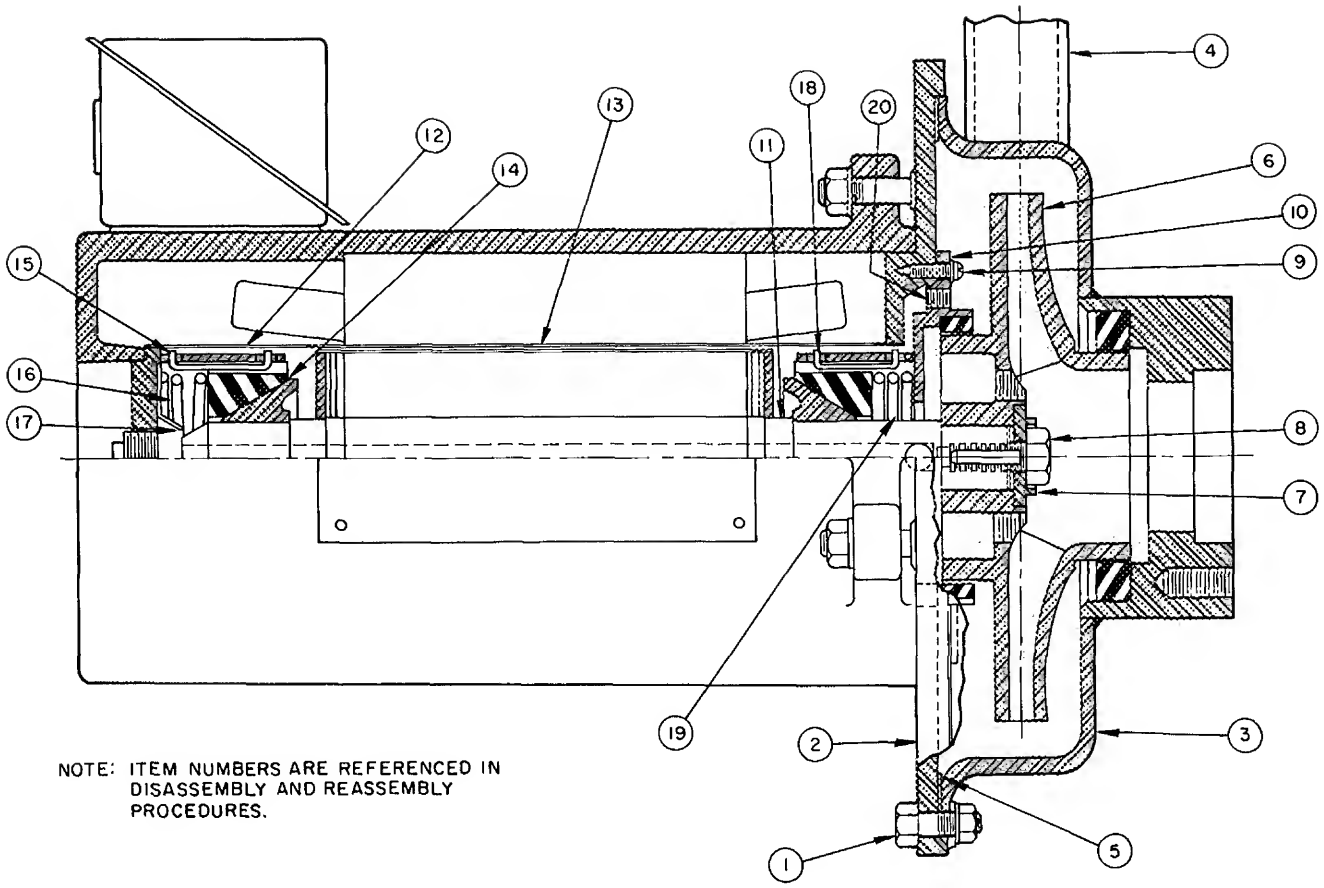

Fig. 2 - F-8 Frame Pumps

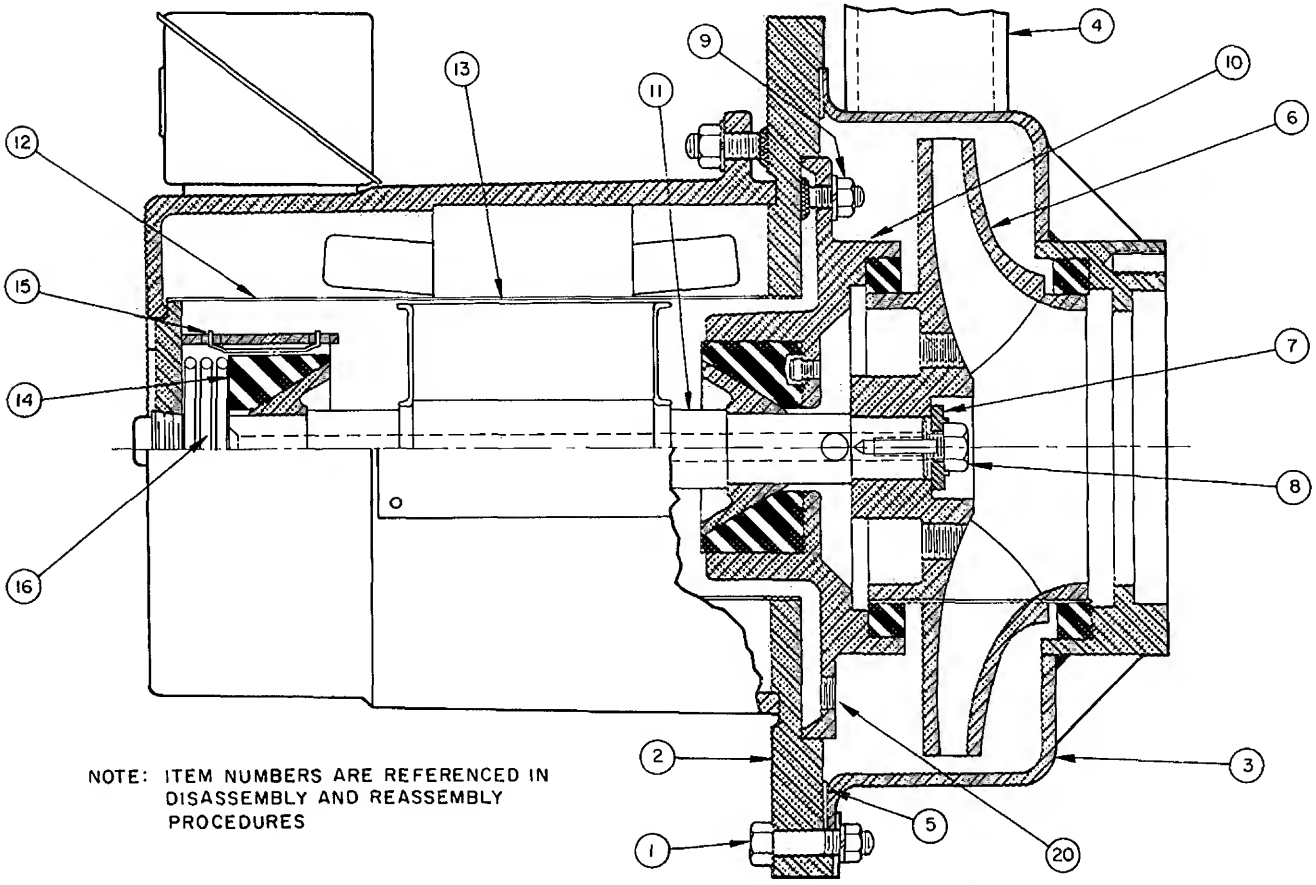

Fig. 3 - F-66 Frame Pumps

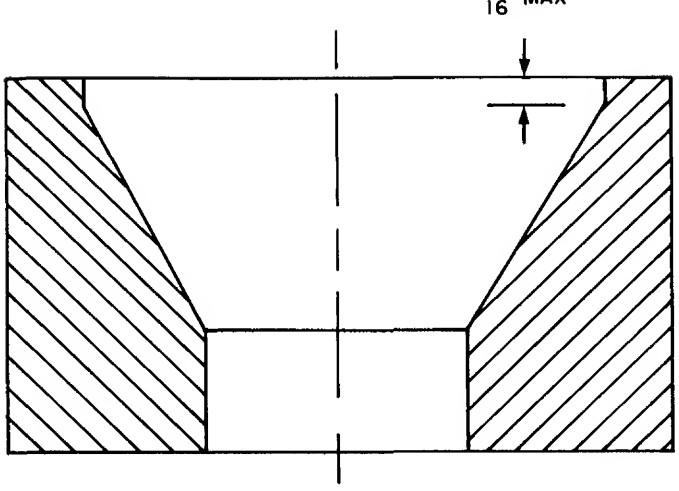

Fig. 4 - Check Bearing Wear

REASSEMBLY PROCEDURES - Refer to Fig. 2 and 3.

1. Clean all parts.
2. Replace wearing rings. Use hand pressure to position new rings.
3. Insert motor end spring and bearing plate (F-8 Frame Pump only).
4. Install retaining clip and spring in bearing housing.
5. Insert motor end bearing into housing. Should be a free sliding fit without excessive radial play.
6. Guide the rotor into position.
7. Install end bearing in bearing and wearing ring housing:
   a. Frame F-8 Pumps - Be sure bearing retainer pin is in the retainer slot.
   b. Frame F-66 Pumps - Be sure bearing retainer pin is in the bearing retainer hole.
8. Install bearing and wearing ring housing. Tighten cap screws (Frame F-8 pumps), or stud nuts (Frame F-66 pumps).
9. Install impeller with impeller key, lock washer and locking bolt. Bend tabs of washers over flats of locking bolt heads.
10. Install new 1/32 in. thick EPR gasket by removing transfer tape from adhesive side of gasket and positioning gasket on adapter flange periphery.
11. Assemble motor stator housing and adapter flange assembly by sliding the housing and adapter flange assembly into pump casing. Refer to step 2 of Disassembly Procedures as to blocking. Install and tighten bolts and washers. Remove blocking.
12. Connect power supply to stator junction box.

AS NEEDED

Adding Octyl Alcohol - Octyl alcohol is usually required when the leaving chilled water temperature starts to rise above design providing the control set point has not been altered. Since a rise in leaving chilled water temperature is also an indication of fouled condensing water tubes, use the following procedure to determine if alcohol is required.

PROCEDURE

1. Remove a sample of solution from solution pump service valve. If solution has no odor of alcohol (very pungent), then octyl alcohol should be added.
2. Add alcohol using the procedure outlined in Carrier Standard Service Techniques, publication SM-16.
3. If alcohol is not required, refer to Troubleshooting Guide for symptoms of fouled tubes.

Log Sheets - We recommend that log sheets be obtained from your Carrier representative and that readings be taken periodically. They are used to:

1. Familiarize operator with machine operation.
2. Be of assistance when planning maintenance.
3. Diagnose machine troubles.

Ordering Spare Parts - Order spare parts from your nearest Carrier office. To speed up the process of filling part orders, the following information must accompany the order:

1. Delivery address.
2. Machine size.
3. Machine serial number.
4. Part name, part number and quantity required.
5. Orders for pump parts must show the motor serial number found on the motor nameplate.

TROUBLESHOOTING

The remedies listed do not represent a series of corrective procedures. They are merely checkpoints and possible individual remedies to machine problems. When the troubleshooting remedies fail to pinpoint a problem, contact your nearest Carrier representative for assistance.

TROUBLESHOOTING GUIDE

SYMPTOM OR DIFFICULTY	POSSIBLE CAUSE	REMEDY
A. Lithium bromide solidifies at start-up.	1. Condenser water too cold.	1. a. Reset cooling tower bypass valve to design conditions. b. Check cooling tower fan control setting.
	2. Air in machine.	2. Purge the machine. Use Carrier Standard Service Techniques, publication SM-16.
	3. Improper purging.	3. a. Check to see that all valves are in correct position. b. Check machine leak rate with purge.
B. Lithium bromide solidifies during operation.	1. Condensing water too cold.	1. a. Reset cooling tower bypass valve to design conditions. b. Check cooling tower fan control setting.
	2. Steam pressure above design.	2. Reset to design conditions.
	3. Vapor condensate temperature too low. (Temperature should never be below 114 F at full load.)	3. Reduce condensing water flow.
	4. Machine requires octyl alcohol.	4. Add octyl alcohol. Use Carrier Standard Service Techniques, publication SM-16.
	5. Improper purging.	5. See Remedy in A-3 above.
	6. Air leakage.	6. Leak test machine.
C. Low capacity	1. Air in machine.	1. Find and repair leak. Purge the machine.
	2. Condenser tubes dirty. Noted by continually rising vapor condensate temperature (above 114 F) at full load.	2. Clean the tubes and take corrective action in water treatment methods. Use the Carrier Standard Service Techniques, publication SM-16.
	3. Improper purging.	3. See Remedy in A-3.
	4. Machine needs octyl alcohol.	4. Add octyl alcohol. Refer to Carrier Standard Service Techniques, publication SM-16.
	5. Improper setting of capacity control valve.	5. Reset capacity control valve to design temperature by turning control point adjuster down.
	6. Insufficient condensing water flow, or temperature too high.	6. a. Reset cooling tower bypass valve to design temperature. b. Check operation of tower fan. c. Check the condenser water strainer.
	7. Solution temperature generator below design at full load. Note correct temperature at full load.	7. a. Raise steam press. to design. b. Unplug the steam strainer or trap.

TROUBLESHOOTING GUIDE (CONT)

SYMPTOM OR DIFFICULTY	POSSIBLE CAUSE	REMEDY
D. Machine shuts down on safety control.	1. Motor overloads.	1. Reset all motor overloads and check reason for failure.
	2. Hermetic pump overload has tripped.	2. a. If pump is out of liquid, add solution or water. b. If pump is solidified, desolidify. (Refer to Solution Desolidification.)
	3. Shutdown on low-temperature cutout.	3. a. Check low-temperature cutout setting. b. Control point adjuster setting too low. Turn up chilled water controller to design. c. Check condensing water temperature control.
E. Solidification during shutdown.	1. Dilution cycle not long enough.	1. Check setting of dilution thermostat. Should be 140 F. If still solidifies reset to lower cutout temperature.
	2. Improper closing of capacity control valve.	2. Check valve closure. Desolidify.
	3. Machine is shut down, but condensing water pump is still running.	3. Manually shut down condensing water pump.
F. Suspect air leakage.	Leakage into vacuum side of machine.	Determine noncondensable accumulation rate. Refer to the Carrier Standard Service Techniques, publication SM-16.
G. Loss of vacuum at shutdown.	Leakage into vacuum side of machine.	Leak test machine.
H. Failure to keep machine purged.	1. Leakage above the pumping rate of purge.	1. a. Perform leak rate check. b. Leak test machine.
	2. Purge not performing properly.	2. a. Valves not opened properly. Check to see that all valves are in correct position. b. Purge solidified. Desolidify. c. Lack of solution flow to purge from solution pump. Contact your Carrier representative.

GENERAL INFORMATION

EQUILIBRIUM DIAGRAM

The Equilibrium Diagram (Fig. 5) is used to determine solution concentration in your machine. It is important to maintain solution concentration within certain limits in order to maintain equilibrium conditions.

The following explains the equilibrium diagram and how to determine solution concentration:

The curved line in the lower right-hand corner is the crystallization line. This line indicates the point at which the solution will begin to change from a liquid to a solid. This sets the limits of the cycle. Crystallization of a solution is quite different from the freezing of a single substance such as water. When water is subjected to a temperature even slightly below 32 F, all of it will eventually freeze. In contrast, when the lithium bromide solution temperature is reduced below the solidification point for that particular concentration, only a portion of the salt will crystallize or freeze. The remainder of the solution will become more dilute or less concentrated and will remain in a liquid state. Crossing of the crystallization line does not necessarily result in solidification provided the subcooling does not progress too far. Solidification of solution will not harm the absorption machine but it will interrupt service. Satisfactory design requires that operation take place above the crystallization line.

The scale on the left represents the straight horizontal lines and indicates the vapor pressure of the solution or evaporator water at equilibrium conditions.

On the right-hand side is the saturation temperature scale for pure water corresponding to the vapor pressures on the left-hand scale. This scale also represents the horizontal lines and is located on the right side to avoid confusion in reading the chart.

The scale at the bottom is for the vertical lines. They represent solution concentration in percent by weight. For example, a solution of 60% is 60% lithium bromide and 40% water by weight.

The curved lines running from left to right are solution temperature lines. These should not be confused with the saturation temperatures.

The curved lines which extend upward from the bottom of the diagram are specific gravity lines. These are used to determine solution concentration. By measuring the specific gravity with a hydrometer and finding the temperature, the percent of concentration can be determined by plotting these two points on the diagram.

Refer to the typical machine absorption cycle plotted on Fig. 5. Points 1 thru 7 represent a complete cycle. Specific point values are given in Table 1. An explanation of each point and the lines drawn between is as follows:

Point 1 - The strong solution as it sprays out of the absorber spray nozzle and starts to absorb refrigerant.

Point 2 - The weak solution as it leaves the absorber and enters the heat exchanger. Line 1-2 represents absorption of the refrigerant thereby diluting solution.

Point 3 - The weak solution after it has passed thru the heat exchanger. Line 1-3 represents the amount of heat gained by the solution in the heat exchanger.

Point 4 - The weak solution entering the generator and being heated. Line 3-4 represents the amount of heat required to start the weak solution to boil.

Point 5 - Maximum solution concentration in the generator after much of the refrigerant has boiled out. Line 4-5 represents the amount of heat required to boil off the refrigerant.

Point 6 - The strong solution as it leaves the heat exchanger on its way to spray nozzles.

Point 7 - The strong solution entering the spray nozzles.

Table 1 - Cycle Data

POINT	SOLUTION TEMP (F)	VAPOR PRESS. (in Hg)	PERCENT LITHIUM BROMIDE SOL	SATURATED TEMP (F)
1	115	0 25	63.3	42
2	101	0 25	59 5	42
3	165	1 65	59 5	95
4	192	3.20	59.5	115
5	215	3 20	64 0	115
6	134	0.45	64 0	55
7	119	0.30	63 0	45

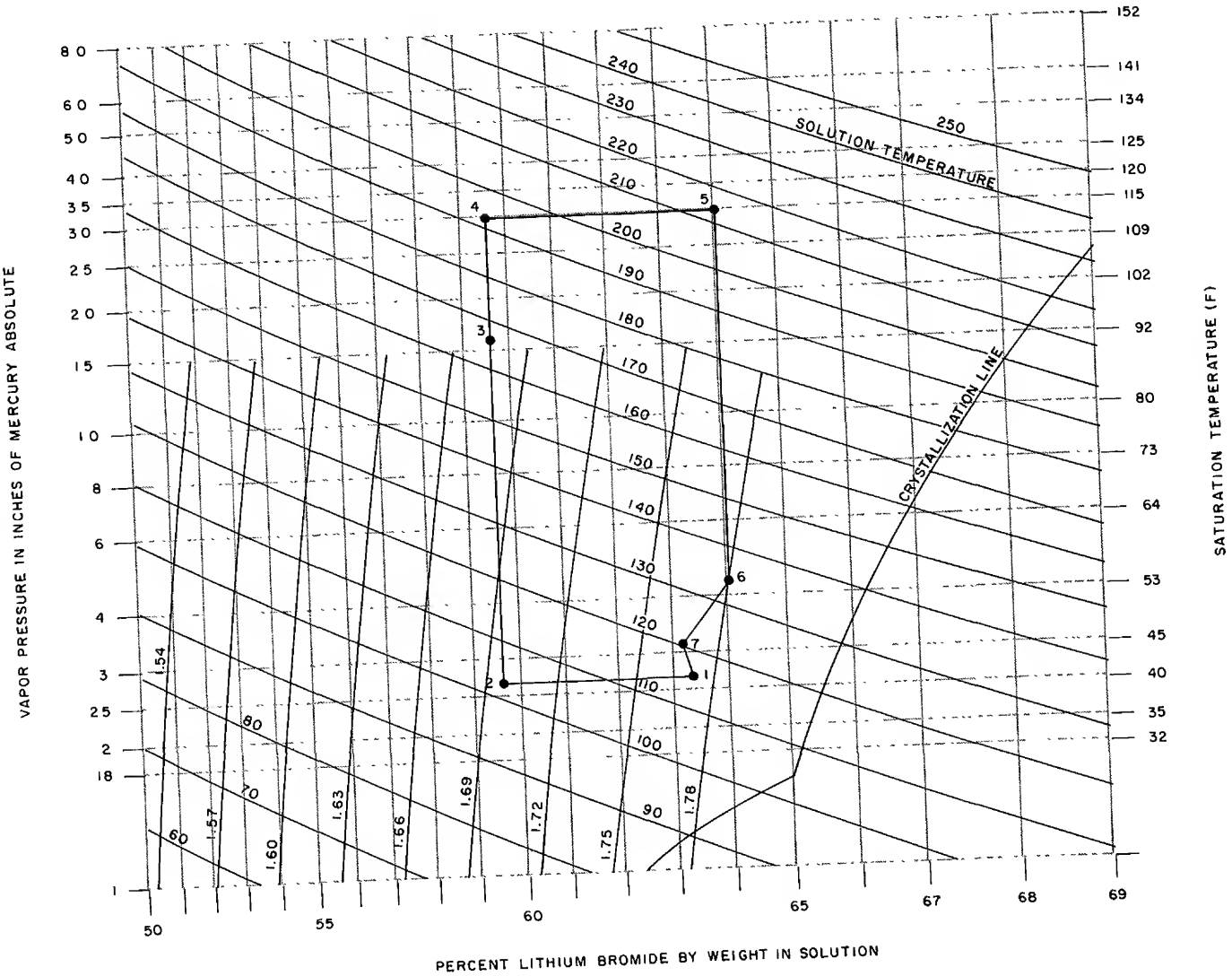

Fig. 5 - Equilibrium Diagram

16JA ABSORPTION CYCLE

Figure 6 illustrates the basic absorption flow diagram. The evaporator-absorber section operates at an absolute pressure of 0.25 in. Hg. As the cooling load passes thru the cooler, the refrigerant picks up heat and is vaporized (boiled) at 40 F because of the low absolute pressure. The vaporized refrigerant migrates to the absorber section due to the strong affinity for water of the lithium bromide solution.

As more refrigerant is absorbed by the solution the absorption rate decreases necessitating regeneration of the lithium bromide solution to a more concentrated form to maintain machine capacity. To accomplish this, diluted solution in the absorber is pumped thru the tube side of a shell and tube heat exchanger where it picks up some heat from the hot strong solution returning from the generator. On leaving the heat exchanger the now warmer weak solution enters the generator, is heated to boiling and the refrigerant is boiled out, becoming a strong solution again. This strong solution leaves the generator and passes thru the shell side of the heat exchanger losing some heat to the weak solution passing thru the tube side.

Usage of the heat exchanger reduces total heat quantity required.

The strong solution returns to the absorber sprays and is then sprayed over the absorber tube bundle where absorption of refrigerant commences again.

NOTE: Solution flow from generator to absorber is the result of gravity and pressure difference and not by a pump.

Refrigerant boiled out of solution in the generator condenses on the condenser water coils and returns to the evaporator via the vapor condensate line. Refrigerant flows into the evaporator sump, where it is pumped to sprays over the evaporator coils and the cycle is repeated.

Capacity Control - A steam control valve is used to control capacity. This valve operates by a controller which senses the temperature of the leaving chilled water. When the temperature is at or above the design point, the machine will be at full load. At this condition the steam control valve is wide open to reconcentrate the solution in the generator. As the chilled water temperature drops below the design point, the steam will be throttled. At no load conditions the steam valve will be closed.

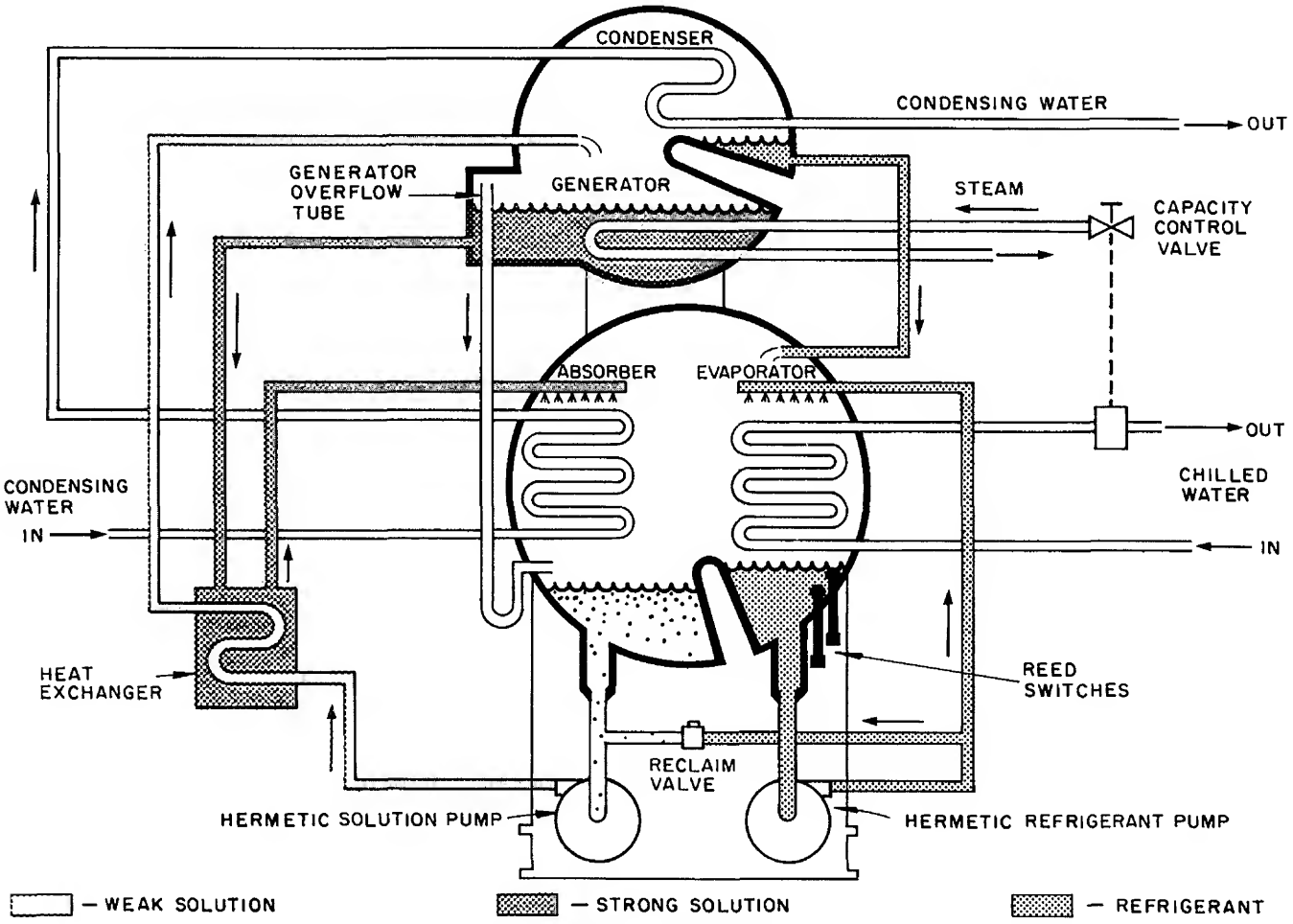

Fig. 6 - 16JA Absorption Cycle